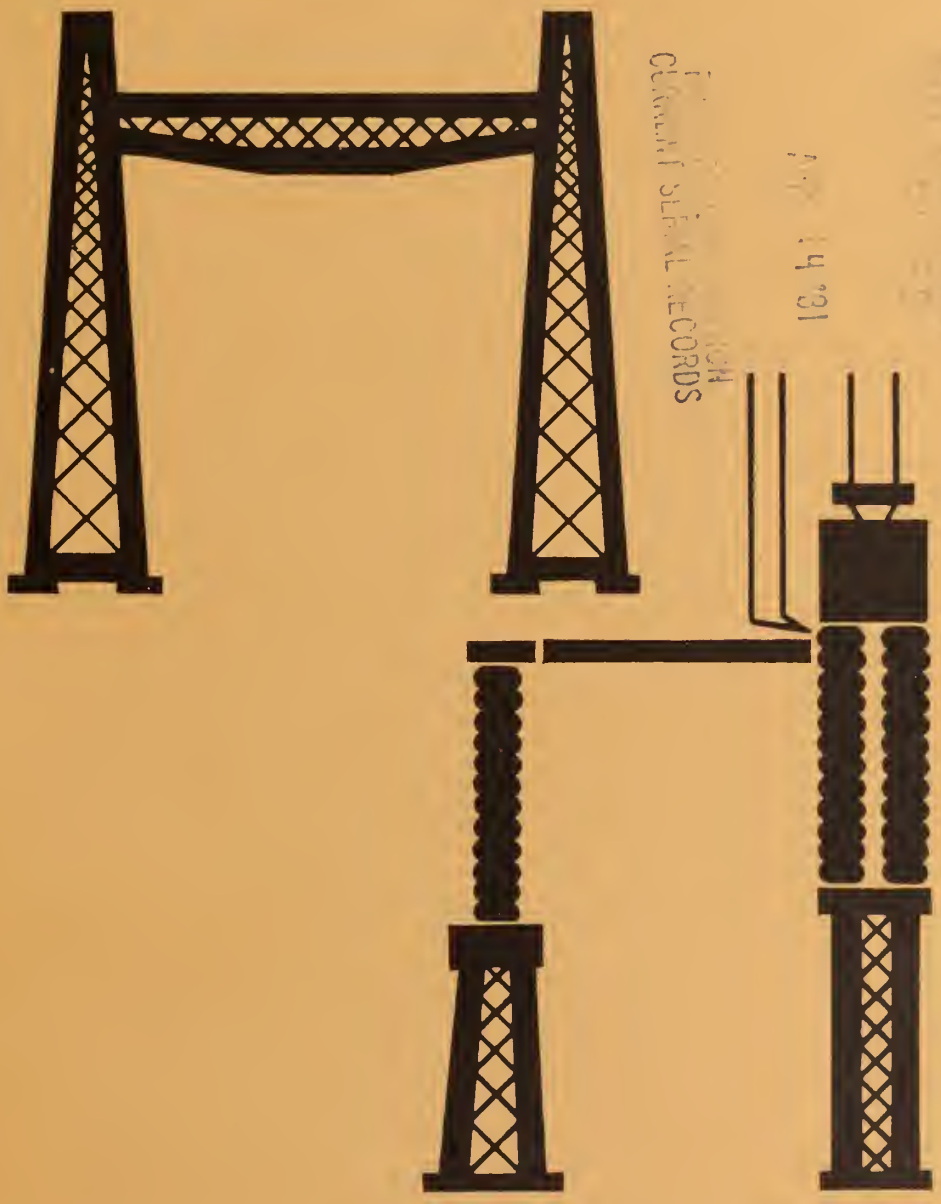
POWER SYSTEM COMMUNICATIONS:

Guide Specification for Power Line Carrier System



REA BULLETIN 66-12

RURAL ELECTRIFICATION ADMINISTRATION • U.S. DEPARTMENT OF AGRICULTURE

JANUARY 1981

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FOREWORD

This Guide Specification has been developed to acquaint the REA Borrowers and their consulting engineers with the essential elements of a properly prepared specification for the procurement of a Power Line Carrier System. It is not intended to be mandatory in structure but rather, it should be used as a tutorial tool and guide in determining what is needed.

It is incumbent upon the user to add, delete and modify as appropriate for the particular system to be procured in conjunction with specific Borrowers' requirements.

JOE S. ZOLLER
Assistant Administrator - Electric

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International System of Units

In December 1975, Congress passed the "Metric Conversion Act of 1975." This Act declares it to be the policy of the United States to plan and coordinate the use of the metric system.

The metric system, designated as the International System of Units (SI), is presently used by most countries of the world. The system is a modern version of the meter, kilogram, second, ampere (MKSA) system which has been in use for years in various parts of the world.

To promote greater familiarization of the metric system in anticipation of the U.S. converting to the system, REA is including metric units in its publications. This bulletin has, therefore, been prepared with the International System of Units (SI) obtained from ANSI Z 210-1976 - Metric Practice. Approximately equivalent Customary Units are also included to permit ease in reading and usage, and to provide a comparison between the two systems.

1.0 USE OF THIS GUIDE SPECIFICATION

1.1 Purpose

The intent of this bulletin is to provide an insight into the basic content requirements for the preparation of a sound, meaningful, and effective system design, engineering, and procurement specification for a Power Line Carrier System.

The Guide Specification is not intended as the solution for total system specification preparation; it is as the title suggests, an aid to those Borrowers who find it necessary to establish definitive specifications to be used by potential bidders. It is emphasized that the bulletin is not directive in nature; rather, its information and its purpose is to aid and supplement that information already available to Borrowers. In this regard, where the word "shall" appears, it is intended to represent the Borrower's expression to the potential bidder.

1.2 Scope

The Guide Specification covers each of the elements potentially requiring contractor assistance in the establishment of a Power Line Carrier System. This total system coverage permits the Borrower to use all or part of the content, dependent on support required. In addition, to covering the various inter-related system elements, the guide provides methods for obtaining contractor or consultant response to Borrower requirements as well as technical specification outlines. This guide provides only the framework for a professional and effective specification, but does not obviate the need for definitive engineering data and professional engineering effort. Indeed, this guide is not intended to be a substitute for thorough system planning and detailed engineering and design. Users of this bulletin must recognize that a thorough knowledge of system requirements must be attained before the bulletin is applied and that this knowledge is a product of adequate analysis and engineering effort. The scope of these activities are not explicitly addressed but their necessity is presumed to be understood.

1.3 Application

As earlier indicated, the contents of the bulletin are designed to permit their use in whole or in part. The solicitation instructions and attendant data (Sections 2.0, 3.0 and 4.0) are pertinent to interface with potential bidders and/or with consulting engineers as requirements dictate. In effect, the bulletin content permits a "cut and paste" capability for initial preparation of the system specification framework. The word "framework" is used advisedly to emphasize the essentiality of engineering input to the final package.

Users of this bulletin are advised to be alert to the impact a parameter specified at one point in the system may have on a parameter value at another point in the system. Borrower Engineers or Consulting Engineers are the obvious source of the data necessary to fill the blanks. The fill data is the critical information which will ensure that each element of the total system meets the parameters essential to system realization, construction, operation, performance, continuity, and maintenance. Firm, definitive data in the basic specification will insure that eventual contractors are technically and legally responsible for the desired results. Delays in system completion caused by insufficient or ambiguous data and the attendant discussions or renegotiations with bidders or eventual contractors, can be avoided by thorough and professional preparation of the specification. It is reiterated that the Guide Specification is only as valuable as the engineering input to the specification. Proper use and application will greatly aid the Borrower in the timely development of a Power Line Carrier System Specification, and serve to expedite any review and approval that may be required of the specification by Rural Electrification Administration.

2.0 SOLICITATION INSTRUCTIONS AND NOTICE TO OFFERORS

2.1 You are invited to submit to (Cooperative Name) _____ (hereafter called the "Purchaser") _____ your proposal for the provision and delivery, F.O.B., to the locations indicated, to include installation of equipment and materials specified, which are to be part of the project known as the _____ Power Line Carrier Communications System, to be financed and accomplished via a financing agreement between the Purchaser and the United States of America (hereafter called the "Government") executed by the Administrator of the Rural Electrification Administration (hereafter called the "Administrator").

Sealed Proposals, to include separate Cost Proposals, will be submitted as follows prior to _____ p.m., local time, (Date) _____.

Original and _____ copies to:

Copy to:

Proposals received or postmarked after the specified time and date shall be considered as "Non Responsive" and will not be considered unless:

- It was sent by registered or certified mail no later than the _____ calendar day prior to the date specified for receipt of offers (e.g., an offer submitted in response to this solicitation must have been mailed prior to _____ or earlier)

Acceptable evidence, as establishing proof of mailing shall be the U.S. Postal Service postmark on the wrapper, or Post Office Receipt.

2.2 Any Sub-Contractor or Material Supplier furnishing either equipment, materials or services under this project to a Prime Contractor must obtain any drawings, specifications or other documents relating to this project from its respective Prime Contractor and not from the Purchaser.

2.3 All proposals, together with other supporting documents, must be submitted on the forms furnished by the Purchaser, delivered in sealed envelopes, addressed as indicated under Paragraph 1.1 supra, with the name and address of the Offeror clearly indicated on the outside envelope containing the proposal.

Proposals must be submitted in conformance with these specifications. Should an Offeror desire to propose alternate equipment, methods in lieu of those contained in the specifications, they shall be clearly defined, and as proposed, satisfy the project requirements, and be submitted as an alternate to the basic specifications. All costs associated with an Alternate Proposal, shall be clearly defined, and furnished separate from those submitted for the basic specification requirements.

Any deviations, exceptions, or clarifications not treated in this manner shall be deemed non-compliant, and will not be considered.

2.4 The Offeror shall furnish with his proposal a complete set of specifications and typical drawings, including dimensions, design calculations and data, installation and maintenance instructions, operating characteristics, and such other information as is required to enable a thorough understanding of the equipment proposed to be furnished.

Unnecessarily elaborate brochures or other presentations beyond that sufficient to present a complete and effective proposal are not desired.

Elaborate art work, expensive paper and bindings, or other expensive visual presentation aids are neither necessary, nor wanted.

2.5 Specific information to be submitted with an Offeror's proposal shall consist of the following:

- PLC equipment availability and reliability calculations
- Comprehensive description of test methods and procedures for factory and field system tests
- A project schedule showing work flow and all major items of work, emphasizing critical project items
- Appendix A, Equipment Design Data
- Appendix B, Link Data/Design Summary Worksheets

- List of critical and recommended spare parts for all items of equipment furnished, to include unit pieces
- List of required or recommended test equipment, to include unit pieces
- Listing of systems of similar design, complexity and operation previously furnished and installed by the Offeror, with names of organizations or persons the Purchaser may contact relative to the same

2.6 Prior to the submission of the proposal, the Offeror shall make and shall be deemed to have made a careful examination of the plans and specifications and forms of equipment contract on file in the office of the Purchaser and with the Engineer, and all other matters that may affect the cost and the time of completion of the work.

2.7 Within _____ days of receipt of this request for proposals, all perspective Offerors shall notify the Purchaser of their intent to bid. This notice shall be addressed to:

If desired by an Offeror, arrangements for a pre-submission meeting with the Purchaser will be made, to meet at the above location for discussion in reference to these specifications.

2.8 All proposals shall be signed by an individual authorized to bind the Offeror, and shall contain a statement that the proposal and Cost Quotations are valid for a period of not less than _____ days after the closing date to provide for proposal evaluation and resolution.

2.9 Any items which are clearly necessary for satisfactory performance shall be considered as part of the contract even though not directly specified. Such items should be noted by the Offeror and included in his proposal response.

2.10 Within _____ days after notice of award is given to the successful Contractor, a conference will be held in the office of the Purchaser for the purpose of discussing the details of the system equipment to be furnished and the schedule and manner in which the manufacturer's drawings are to be prepared and submitted. The Offeror shall have present at this meeting, the project engineer responsible for this project.

2.11 Any exception to those specifications must be clearly indicated by the Offeror using the following format:

a. Paragraph number

b. Exception taken and reason

c. Suppliers recommendations, substitution, or alternative

2.12 The contract, when executed, shall be deemed to include the entire agreement between the parties thereto, and the Offeror shall not claim any modification thereof, resulting from any representation or promise made at any time, by an officer, agent, or employee of the Purchaser or by any other person.

The Purchaser reserves the right to reject any or all proposals.

_____
(Cooperative Name)

_____ BY: _____
DATE

3.0 CONTRACT FORMS

The appropriate REA standard contract forms should be used. Usually, these forms will adequately express the intent of the parties to the contract. However, some modification of the standard form may be required in order to obtain the detailed description of services and work needed for a specific undertaking. When contemplating such changes, care should be exercised to prevent those changes from relieving the contractor of any of the responsibilities required of the REA standard form.

4.0 SCOPE OF PROJECT

This section should provide the qualitative information about the project that places it in clear perspective and, together with the detailed specifications, leads to as complete an understanding of the mission to be accomplished as practicable. This information should be in the form of a comprehensive summary that provides a general overview of the system, its objectives and requirements, equipment to be supplied, and a clear indication of the system's size and complexity. Information supplied should be concise, but, at the same time, in sufficient depth to ensure the quality of bids to be received.

Clear functional information about the system should be included. Uncertainty about the functional requirements can translate into additional system costs because increased flexibility must be designed into the system. While flexibility may be desirable if it can be obtained at little cost, it is often costly in terms of available resources and obtained at the expense of other valuable features. Functional information about the system should include terminal and repeater locations, spur branching points, direction of information flow and the type of information to be transmitted, channel types and quality, compatibility with existing equipment and services, and capability for expansion.

5.0 PLC SYSTEM PERFORMANCE

5.1 General

The transmission, channelization, and line equipment, when integrated into the system, shall meet the requirements set forth herein.

5.2 Signal-to-noise ratio

The minimum carrier signal-to-noise ratios for the specific applications are given as follows:

Voice Communication	15dB, minimum
Tone Telemetering	15dB, minimum for single tone (15 + 20 log N dB for N tones)
Carrier Relaying or Supervisory Control	20dB, minimum
Keyed Carrier Telemetering	15dB, minimum

This specification shall be met during normal weather related transmission degradations.

5.3 Frequency Allocation and Bandwidth

The Offeror shall propose equipment that meets the following channelization and frequency plan. (The Borrower should provide his required plan based on his required number of voice, telemetry, data, signaling, and protective relaying channels).

5.4 Channel Usage

The Offeror shall design his system to accommodate the channel usage as shown in Table 5-1.

5.5 Return Loss

The Offeror shall ensure that when the equipment is connected to the transmission line, the return loss for any audio frequency transmitted through the system and at any RF carrier junction point shall be at least 26dB.

5.6 Audio Level Stability

Variation in voice frequency levels throughout the system shall not exceed 0.5dB per month.

5.7 Frequency Stability

Change in audio frequency through the system shall not exceed 2Hz. The Offeror shall state how this requirement will be met in his proposal.

5.8 Pilots

The Offeror shall provide a pilot subsystem as follows: (The Borrower should state his requirements).

5.9 Engineering Calculations

For each type circuit listed in the Channel Usage Table, the Offeror shall provide the calculations for system end-to-end performance. The calculations shall include all assumed system losses and noise levels.

Table 5-1

Sample Channel Usage

From	To	Type Circuit
Substation BRAVO	Central Control	Telemetry

Table 5-2

Voice Frequency Transmission Levels

(Representative List)

	2-wire term.	4-wire term
Min. voice input level for full modulation	0dBm	-16dBm
Max. voice output level	_____	_____
Min. tone input level (speech-plus) each tone*	_____	_____
Max. tone output level (speech-plus) each tone*	_____	_____
Min. tone input level (tone only)	NA	_____
Max. tone output level (tone only)	NA	_____
Min. tone input level (data channel)	NA	_____
Max. tone output level (data channel)	NA	_____

*NOTES

1. Tone ports are 4-wire.
2. Audio characteristics are for non-compandored channels.
3. Tone levels given are for each tone.
4. Tone levels are for standard adjustments using six tones above voice for speech-plus, and 10 tones for tone only operation.

6.0 CHANNELIZATION EQUIPMENT

6.1 General

The channelization equipment provides the basic modulation and demodulation steps in SSB voice channel communication systems as shown in Figure 6.1. In addition, the channelization equipment includes terminating interfaces and line conditioning for:

- Audio bridges
- Data (wide and narrow band)
- Foreign exchange (office and central)
- PABX voice trunks
- Speech plus data voice circuits
- Speech plus out of band signaling voice circuits
- Signaling
- Voice compandors

These interface and conditioning functions are specified in Paragraph 6.2 along with the channelization equipment.

Channelization equipment on FSK relaying and supervisory control communications equipment includes the frequency shift keying, modulation of the RF carrier, optional voice channel orderwire, communications modulator and receiver, plus the power amplifier, and an RF hybrid as shown in Figures 6.2 and 6.3. This equipment is specified in Paragraph 6.3.

6.2 SSB Communications

This specification sets the minimum performance requirements for voice channel carrier multiplex equipment (MUX). Unless otherwise specified, characteristics apply to two multiplex channel terminals connected back to back on the HF line.

6.2.1 Design Features

6.2.1.1 The MUX equipment shall be of all solid state design except for the signaling and alarm relays.

6.2.1.2 Capacity, initially, shall be capable of handling up to ___ single sideband channels. Future requirements may dictate expansion to ____ channels over each route. Offerors shall consider and detail the requirements necessary to expand the MUX to a ____ channel operation.

6.2.1.3 Channel modems shall be mounted in standard EIA self-supporting racks not exceeding ____m in height.

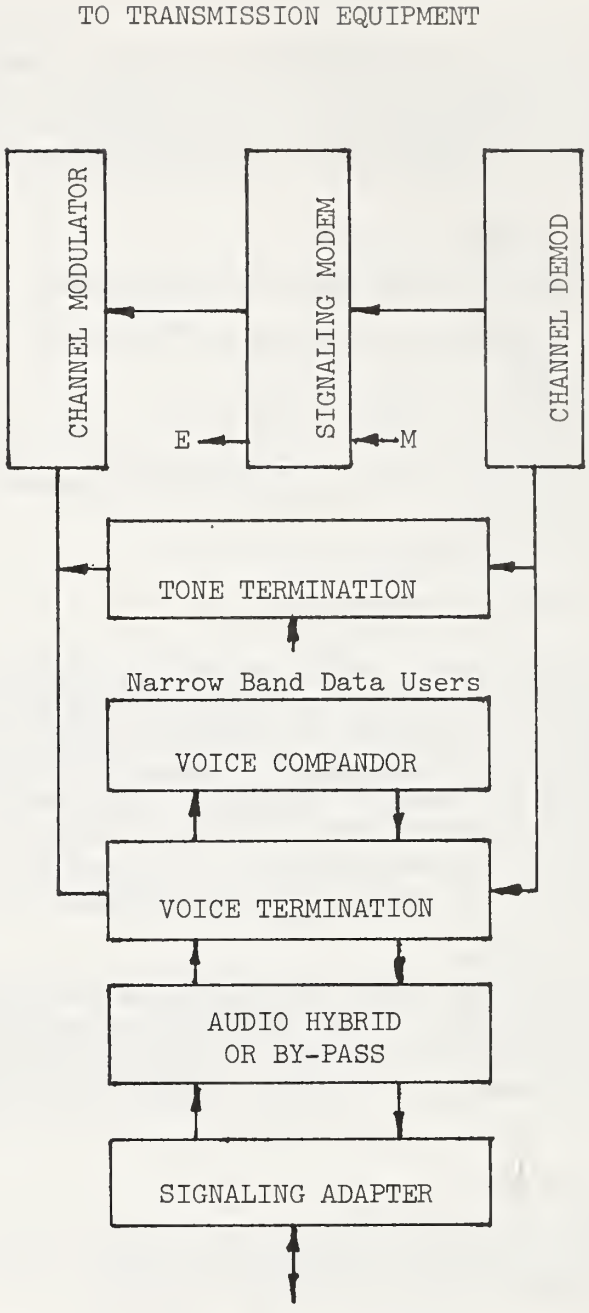

Figure 6.1
SSB Channelization Equipment Configuration

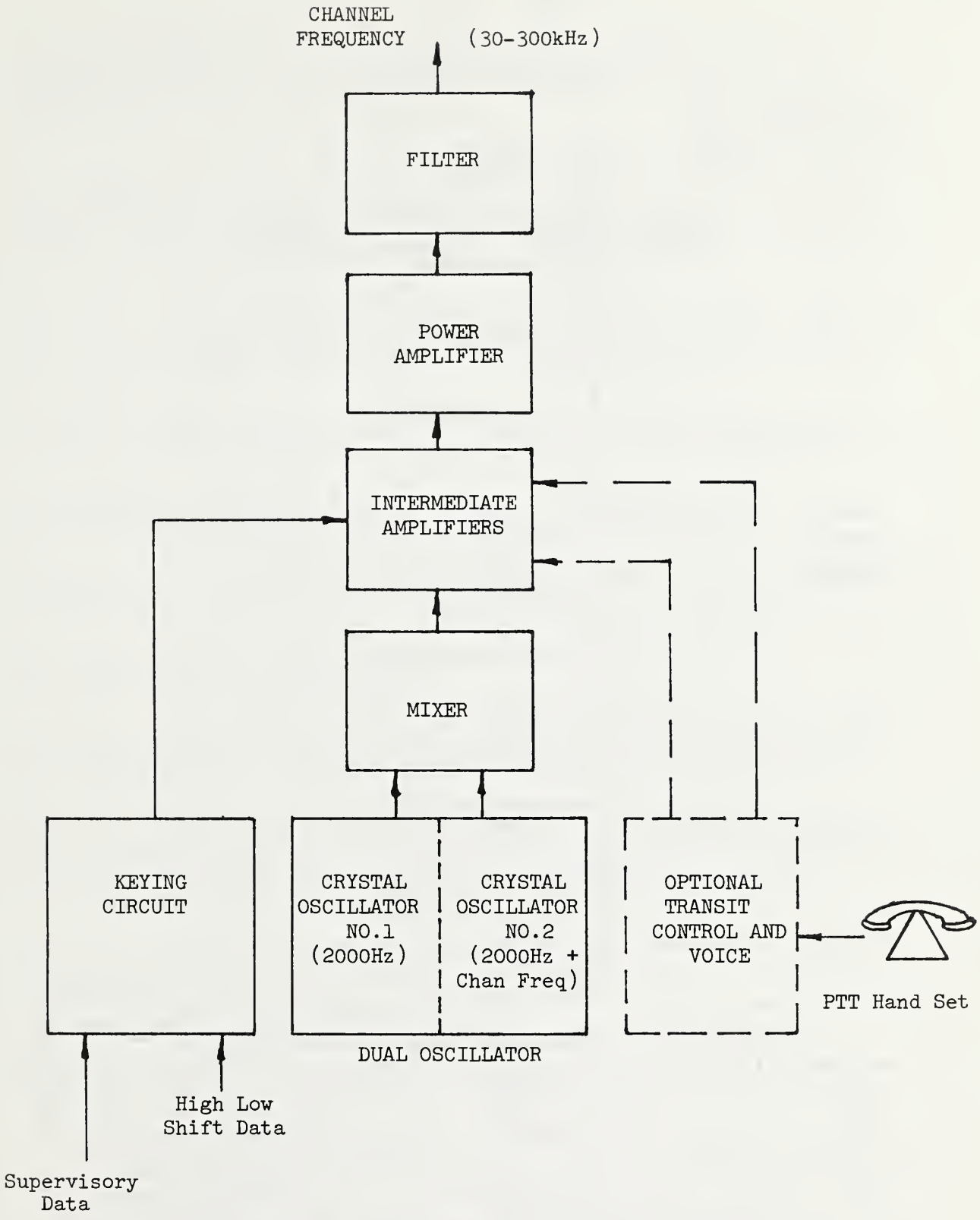

Figure 6.2
FSK Transmitter Configuration

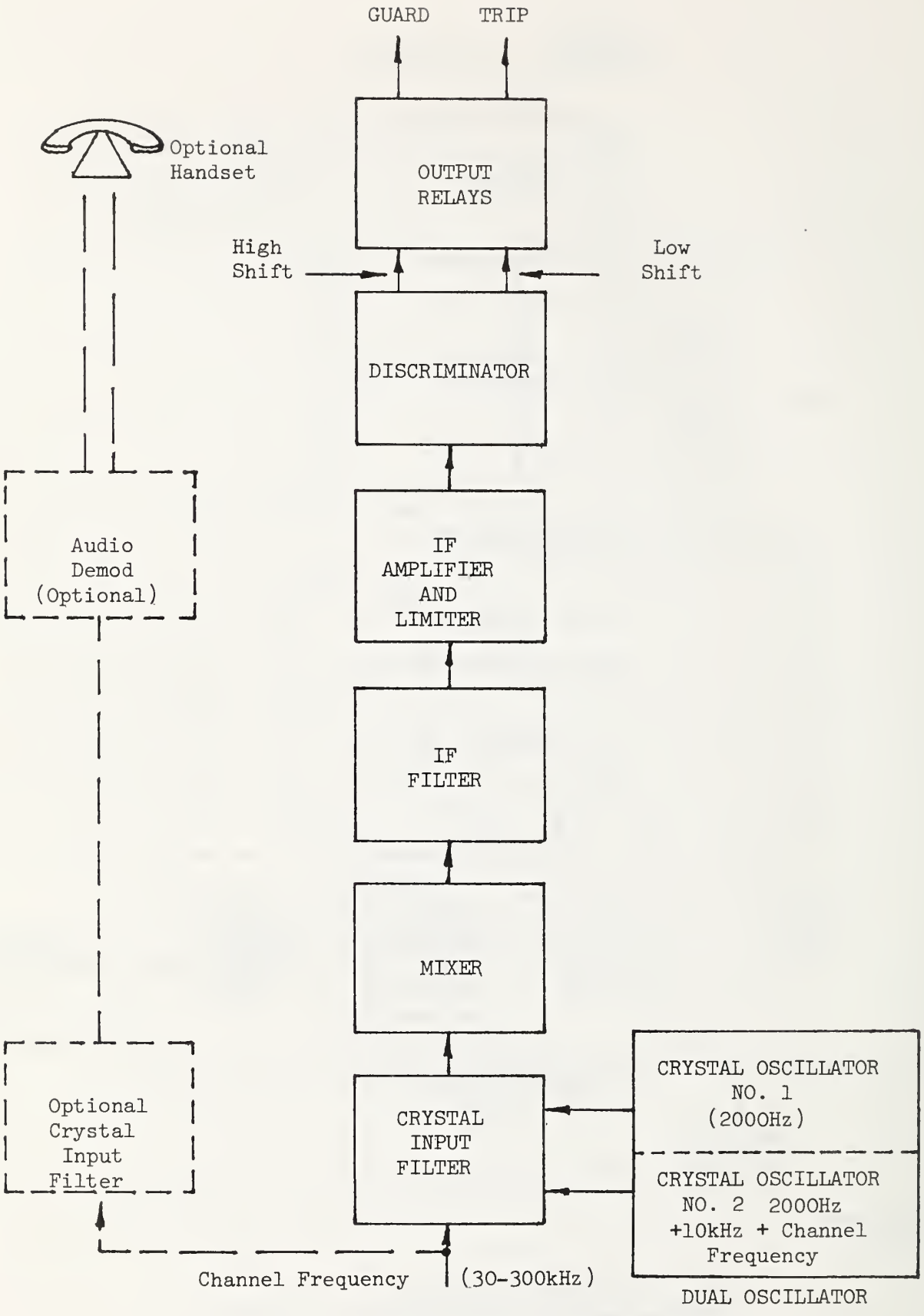

Figure 6.3
FSK Receiver Configuration

6.2.1.4 The system frequency plan shall comply with CCITT recommendations. If frequency plan does not comply, the Offeror shall explain plan in use. Modulation and sideband allocations are to be explained.

6.2.1.5 E&M Signaling, as may be required, shall be built into or plugged into the channel modem. Offeror shall denote how frequency determining elements are connected to the channel modem. Any other signaling media offered shall be consistent with the technical specifications stated herein.

6.2.1.6 All performance specifications shall be met, with the equipment being powered from an unregulated dc source with up to ____ millivolts RMS ripple, or an unregulated ac source of ±10% variation.

6.2.1.7 The channel transmitter shall include amplitude limiting as required.

6.2.1.8 Redundance of active common channel elements and associated sensing equipment shall be detailed.

6.2.1.9 All power input circuits shall have reverse polarity protection.

6.2.1.10 Offeror shall state maximum channel loading capability for full channel complement.

6.2.1.11 The SSB equipment shall be of modular construction with all modules and sub-modules being of the plug-in type. No soldering shall be required to add signaling options.

6.2.1.12 Expansion shall be accomplished by either plugging modules into pre-wired shelf spaces, or by adding shelves to existing racks, without need for removing or relocating existing equipment, and shall be so specified.

6.2.1.13 Offerors shall state the cost of adding a single channel associated with expansion operations.

6.2.1.14 Environmental Conditions

The performance specifications listed in this Bulletin shall be met under any combination of the following conditions:

- ° Temperature -_____°C to +_____°C
- ° Humidity _____ to _____% non-condensing
- ° Altitude Sea level to ____ meters AMSL
- ° Seismic ____G at base of mounting rack (____ to ____ Hz)
- ° Transit Voltage ____V, ____MHz as per IEEE 472-1974

6.2.1.15 Ample test points, controls and indicators shall be provided to facilitate preventive and corrective maintenance with standard test equipment. No unique tools or test items, except for a card or module extender, shall be specified.

6.2.1.16 All controls, test points, adjustments and operational circuits shall be accessible from the front of the rack.

6.2.1.17 Individual channel alarm indication, visual bay alarm and contacts for remote alarm shall be provided.

6.2.2 Performance Parameters

6.2.2.1 Carrier Leak

Carrier leak shall not exceed _____dBmO except when a carrier is used for signaling or synchronization.

6.2.2.2 Crosstalk

Combined near-end, far-end, and adjacent crosstalk shall not exceed ____dBrnCO (_____dBmO).

6.2.2.3 Envelope Delay

Envelope delay shall meet Bell type circuit 3002 (C4) conditioning requirements.

6.2.2.4 Return Loss

6.2.2.4.1 Voiceband

4 wire:	_____	dB minimum 300Hz to 3400Hz
2 wire	_____	dB minimum

6.2.2.4.2 Baseband

Normal level:	_____	dB minimum
High level:	_____	dB minimum, ERL

6.2.2.5 Harmonic Distortion

Total harmonic distortion shall not exceed _____% at 1 kHz, 0 dBmO test tone of any frequency within the pass band.

6.2.2.6 Idle Noise

Idle Noise shall not exceed _____ dBrnCO per channel.

6.2.2.7 Longitudinal Balance

Longitudinal balance shall be at least _____dB, 4-wire circuit and _____dB, 2-wire circuit.

6.2.2.8 Level Stability

Level stability shall not vary by more than ±_____ dB per month.

6.2.2.9 Phase Jitter

Phase jitter shall not exceed ___ degrees peak-to-peak at a 1kHz test tone.

6.2.2.10 Signaling Distortion

Signaling distortion shall not exceed ____% over a ±____dB operating level range with a 30% to 70% make-break ratio.

6.2.2.11 Test Tone Levels

6.2.2.12 Voice band:

6.2.2.12.1 Transmit: 2-wire, ___ to ___dBm (adjustable)
4-wire, ___ dBm

Receive: 2-wire, ___ to ___dBm (adjustable)
4-wire, ___ to ___dBm (adjustable)

6.2.2.12.2 Baseband:

Transmit: ____ to ____ dBm (adjustable)

Receive ____ to ____ dBm (adjustable)

6.2.2.13 Channel Frequency Response

300 Hz to 3400 Hz: ____ dB to ____ dB
600 Hz to 2400 Hz: _____ dB
(Referenced to 1 kHz)

6.2.2.14 Impedance

6.2.2.14.1 Voiceband:

2-wire, 600 or 900 ohms, balanced
4-wire, 600 ohms, balanced

6.2.2.14.2 Baseband:

_____ ohms

6.2.2.14.3 Data:

_____ ohms narrow band low data

_____ ohms wide band (voice channel) medium speed data

6.2.2.15 Power Requirements

The channelization equipment shall operate from -44 to -56 volts dc, 120 to 138 volts dc, or 120 volts AC. Offerors shall explain the method of converting a channel modem from one voltage to the other.

6.2.2.16 Overload Protection

Protection of multiplex equipment shall be explained by the Offeror in his proposal.

6.2.2.17 Signaling Options

Signaling options shall be listed and explained. The cost of the various signaling options shall be included as part of the proposal pricing.

6.2.2.18 Signaling

Signaling frequency shall be stated by Offeror, with options available, and explanation of any limitations.

6.2.2.19 VF Levels

6.2.2.19.1 2-wire:

Send level: ____dBm to ____dBm

Receive level: ____dBm to ____dBm

6.2.2.19.2 4-wire:

Send level: ____dBm

Receive level: ____dBm to ____dBm

6.2.2.20 Hybrids

Hybrid circuits required to convert 4-wire operation to 2-wire operation shall be equipped with a balance control and shall be of the transmission type.

6.2.2.21 Jackfields

Jackfields shall be provided for all channels. Jacks for each channel shall include:

- Channel mod tip and ring
- Equipment out tip and ring

6.2.2.22 Terminating Options

The Offeror shall state the availability, cost, and/or modifications to the following terminating options:

- 2-wire, 600 ohm, no signaling
- 4-wire, 600 ohm, no signaling
- 2-wire, E&M signaling
- 4-wire, E&M signaling
- 2-wire, loop originating for FX phone extension, PABX end

- 2-wire, loop terminating for FX extension, equipped with idle line termination, AC ringdown and ringdown trip
- 2-wire/4-wire, E&M signaling, PABX tie trunk
- 4-wire, 600 ohms for narrow band tone, data on speech plus or multi channel narrow band data transmission

6.2.2.3 Voice Compandor

The Offeror shall provide the option of a compandor with the following characteristics.

Harmonic Distortion less than		_____%
VF Level Stability	±	_____ db
Tracking	±	_____ db
Gain Variation 800 Hz	±	_____ db

6.3 FSK Relay Equipment

The Offeror shall meet the following minimum performance requirements for FSK relay and optional voice orderwire terminal equipment. Unless otherwise specified, characteristics apply to a pair of terminal equipment connected back to back at RF level with power amplifier and appropriate attenuators in line.

6.3.1 Design Features

6.3.1.1 The terminal equipment shall be of all solid state design except for signaling and alarm relays.

6.3.1.2 The terminal equipment shall be mounted in a standard EIA self supporting equipment rack not exceeding ____m in height.

6.3.1.3 The system frequency plan shall comply with CCITT recommendations. If CCITT recommendations are not complied with, the Offeror shall explain plan in use with modulation and sideband allotments explained.

6.3.1.4 All performance specifications shall be met with equipment being powered from either an unregulated dc or ac power source, as stated in Paragraph 6.2.1.6.

6.3.1.5 The FSK equipment shall be of modular construction with all modules and sub-modules being of the plug-in type. No soldering shall be required to add signaling options.

6.3.1.6 Expansion shall be accomplished by either plugging modules into pre-wired shelf spaces, or by adding shelves to existing racks, without need for removing or relocating existing equipment, and shall be so specified.

6.3.1.7 Environmental Conditions

The performance specifications listed in this document shall be met under any combination of the following conditions:

- ° Temperature ____°C to +____°C
- ° Humidity ____ to ____% non-condensing
- ° Altitude Sea level to ____ meters AMSL
- ° Seismic ____G at base of mounting rack (____ to ____ Hz)
- ° Transit Voltage ____V, ____MHz as per IEEE 472-1974

6.3.1.8 Ample test points, controls and indicators shall be provided to facilitate preventive and corrective maintenance with standard test equipment. No unique tools or test items, except for a card or module extender, should be specified.

6.3.1.9 All controls, test points, adjustments and operational circuits shall be accessible from the front of the rack.

6.3.1.10 Individual channel alarm indication, visual bay alarm and contacts for remote alarm shall be provided.

6.3.1.11 All power input circuits shall have reverse polarity protection.

6.3.2 Performance Parameters

6.3.2.1 Frequency

The transmitter and receiver shall operate as fixed frequency units in ___kHz intervals on specified frequency of ____kHz. The equipment shall have an RF output and input operating frequency capability of ____kHz to ____kHz.

6.3.2.2 Frequency Stability

The transmitter and receiver shall have a maximum frequency variation of ____Hz at ____°C, with a power supply input voltage change of ±_____%.

6.3.2.3 RF Impedance

The transmitter shall have ____ohms output impedance. The receiver shall have ____ohms input impedance.

6.3.2.4 Keying Methods

The transmitter shall be capable of accepting the following keying methods:

- External contact that applies a voltage into an isolated keying circuit from a separate battery
- External Dry (Dedicated) Contact
- Solid-State Input
- Optional Voice Orderwire Modulation

6.3.2.5 Frequency Shift

The transmitter output frequency shall not shift more than ____Hz from specific frequency when using three freqeuncy keying. The optional voice orderwire modulation shall not deviate from the specified frequency by more than ____Hz.

6.3.2.6 RF Power Output Level

The RF power output level shall be _____ watts measured at transmitter output terminals over specified frequency operating range.

6.3.2.7 Harmonic Suppression

The harmonic suppression of the transmitter shall be at least ____dB below output carrier frequency at specified power output level over operating frequency range.

6.3.2.8 Receiver Sensitivity

The receiver sensitivity shall be a minimum of ____ volts across ____ ohm input.

6.3.2.9 Receiver Bandwidth

The receiver input bandwidth shall be ____kHz for FSK and ____kHz for optional voice orderwire.

6.3.2.10 Receiver Selectivity

The receiver selectivity shall be better than _____dB at ±____kHz for FSK and ____dB at ±_____kHz for optional voice orderwire in relationship to received carrier frequency.

6.3.2.11 Receiver Outputs

The receiver shall provide a minimum of three outputs for FSK and one output for optional voice orderwire as stated in 6.3.2.4.

6.3.2.12 Power Requirements

The transmitter and receiver shall operate from -44 to -56 volts dc, -120 to -130 volts dc, and 120 volts ac. Offerors shall explain the method used to convert the equipment operation from one voltage to another.

6.3.2.13 Overload Protection

The Offeror shall explain how overload protection of the equipment is accomplished.

6.3.2.14 Jackfields

Jackfields shall be provided for each FSK and optional voice orderwire circuit.

6.3.2.15 Optional Voice Orderwire

The optional voice orderwire terminal shall provide a circuit with noise not to exceed ____dBrnCO for transmission path with ____dB carrier to noise signal at receiver input terminals. The terminal shall be equipped with one four-wire, push-to-talk hand set.

7.0 TRANSMISSION EQUIPMENT

7.1 General

The transmission equipment includes the carrier generation system, power amplifier, power supply, and other common equipment.

7.2 SSB Communications

7.2.1 Carrier Generation System

7.2.1.1 Group Transmit Unit

- Spurious Output
  Spurious output out-of-band shall be at least 60dB below the level of the carrier.
- RF Impedance
  RF impedance shall be nominally 50 ohms, unbalanced.

7.2.1.2 Group Receive Unit

- Image Rejection
  Image rejection shall be at least 80dB below the level of the carrier.
- Selectivity
  Attenuation at 0.3kHz from the band edge shall be at least 60dB below the level of the carrier. Attenuation at 4kHz from the band edge shall be at least 90dB below the level of the carrier.
- Sensitivity
  The receive unit shall be capable of detecting a carrier having a level as low as -40dBm.
- RF Impedance
  RF impedance shall be nominally 50 ohms, unbalanced.

7.2.1.3 Pilot Insertion Unit

Pilot level shall not exceed -10dBmO. The Offeror shall specify the frequency of the pilot.

7.2.1.4 Carrier Generator

- Frequency Stability
  The frequency of the master oscillator shall not vary by more than ± 0.5Hz per month.
- Frequency Range
  The carrier system shall be capable of providing a frequency range of 8-400kHz.

° Minimum Channel Spacing
The Offeror shall specify the minimum channel spacing between adjacent edges of the transmit and receive bands.

7.2.2 Power Amplifer

7.2.2.1 Output Level
The Offeror shall specify the required output level to meet the signal-to-noise requirements specified in Section 5.0. The level specified shall be supported by system performance calculations.

7.2.2.2 Output Filter
A surge type of output filter shall be provided to protect against transients originating from the power line.

7.2.2.3 Hybrid Unit
A hybrid unit shall be provided to permit simultaneous transmission and reception of frequencies. The Offeror shall specify transmit and receive insertion losses and the isolation between transmit and receive ports.

7.2.2.4 Redundancy
All common equipment shall be redundant to preclude traffic interruption to more than one channel at a time.

7.3 FSK Communications
Specifications for the transmission equipment associated with FSK Communications is included in Section 6.0.

8.0 LINE EQUIPMENT

8.1 General

Line equipment as covered under this section is stated to be that equipment which is connected to the power transmission line, and which in the performance of its function, prepares and conditions the line for the transmission of the power system's communications, which include, but are not limited to voice, telemetry, control, data, and system protection. The guide specifications contained in this section are associated with the following Line Equipment: Coupling Capacitors, Insulated Shield-Wire Couplers, Line Tuners, and Line Traps.

The guide specifications are intended to provide design objectives, and functional goals, and limits for the line equipment covered.

8.2 Coupling Capacitor

8.2.1 General

Each coupling capacitor shall be housed in a porcelain insulator mounted on a weatherproof base.

8.2.2 Over-Voltage Protection

A network shall be included in the assembly to provide protection during over-voltage conditions.

8.2.3 Rated Capacitance

The capacitors shall have a rated capacitance if not less than _____pF.

8.2.4A Coupling Capacitor Configuration

The coupling capacitor shall be configured to permit connection of power line carrier accessory equipment.

8.2.4B Coupling Capacitor Voltage Transformer

The coupling capacitor shall be configured to provide low voltage for measurement, control and protective functions.

8.2.5 Standards

The coupling capacitor shall conform to ANSI Standards C-93.1-1972 and C-93.2-1976.

8.3 Insulated Shield Wire Coupler

8.3.1 General

The coupler shall be single/dual circuit suitable for cantilever/pedestal/suspension mounting. A ground switch for the insulated shield wire shall/shall not be provided.

8.3.2 Carrier Frequency Attenuation

Attenuation to the carrier frequency shall be less than 2dB over the 12-400kHz frequency range.

8.3.3 Impedance

Input impedance shall be 50 ohms nominal. Output impedance shall be 500 ohms nominal for single circuit and 900 ohms nominal for dual circuit configuration.

8.3.4 Peak Carrier Level

The coupler shall be capable of passing 200 watts of peak carrier power.

8.3.5 Line Current

The coupler shall be able to withstand 100 amperes RMS 60Hz current continuously without overheating.

8.3.6 Basic Impulse Insulation Level

The basic impulse insulation level for coils and capacitors shall be _____ and _____, respectively.

8.3.7 Mechanical Current Capacity

The coupler shall mechanically withstand a peak current value of at least _____kA.

8.4 Line Tuner

8.4.1 General

Each tuner shall be mechanically and electrically configured to permit the following method of coupling: (select applicable method).

- ° Phase to ground
- ° Phase to ground (carrier bypassing)
- ° Phase to phase
- ° Phase to phase (separate circuits)
- ° Three phase

A drain coil shall/shall not be provided.

8.4.2 Carrier Frequency Attenuation

Attenuation of the carrier frequency shall be less than 2dB over the 12-400kHz frequency range for single frequency operation and less than 5dB for two frequency operation.

8.4.3 Peak Carrier Level

The tuner shall be capable of passing 200 watts of peak carrier power.

8.4.4 Tuner Type

The tuner shall be configured for the following type operation: (select applicable type).

° Single frequency
° Two frequency
° High pass
° Bandpass

8.5 Line Trap

8.5.1 General
The line trap shall be configured for suspension/pedestal mounting.

8.5.2 Carrier Frequency Impedance
Impedance over the bandwidth of the carrier frequencies shall be at least 400 ohms.

8.5.3 Current Rating
The line trap shall have a continuous current rating of _____ amperes.

8.5.4 Insulation
The line trap shall use air-insulation/fiberglass-epoxy-insulation.

8.5.6 Line Trap Type
The line trap shall be configured for the following type operation: (select applicable type).

° Untuned
° Single frequency resonance
° Two frequency resonance
° Field wideband tuning
° Adjustable wideband tuning

8.5.7 Standards
The line trap shall conform to ANSI Standard C-93.3-197X.

8.6 Environmental Specifications
The coupler shall meet the electrical specifications described in Paragraphs 8.2 through 8.5 over the ambient temperature range of -40° to +45°C and at altitudes up to 3000 feet.

9.0 ALARM SYSTEM

9.1 General

Offerors shall furnish all equipment necessary to make operational an alarm system for the purpose of monitoring the power line carrier equipment. Each location shall be equipped with an alarm transmission system to transmit the system status at that station to a master station located at a centralized facility.

9.2 Design

The alarm system requirement shall be of all solid state design. It may either be of the continuously monitoring type or the interrogating type. Fail safe operation shall be provided. Circuitry shall be mounted on plug-in cards or modules mounted in equipment shelves or card cages.

9.3 Remote Requirements

Remote terminals shall be capable of receiving alarm inputs for normally open, normally closed, supply voltage, or ground conditions.

The remote unit shall have capability of providing control outputs by addition of equipment only. Control outputs are not to be included in the initial system configuration.

Each remote terminal shall be equipped with the following features:

- ° Local display to provide front panel indication of each alarm input
- ° Alarm memory to assure that all alarms lasting greater than_____ms will be transmitted by the remote unit

Remote terminals shall operate on a nominal -24 volt DC or -48 volt DC. Option shall be field selectable and shall be selected on the basis of the station power source.

9.3.1 The remote alarm unit shall be located in the unattended sites, and must be capable of continuous operation without corrective maintenance under the following conditions:

- ° Operating Temperature Range ___°C to ____°C
- ° Ambient Humidity ___% to ____% non-condensing
- ° Power ___VDC to ___VDC with ___MV p-p ripple

9.3.2 The remote alarm units shall operate from a _____ VDC power source and transmit the status of a minimum of ____ alarm points. The remote alarm units shall be easily expandable to _____ alarm points. Offerors shall detail this expansion capability in his proposal.

9.3.3 Each remote alarm transmitter shall be wired to transmit the following alarms initially:

- ° Receiver failure (all major alarms connected in parallel)
- ° Transmitter failure (all major alarms connected in parallel)
- ° Loss of power
- ° Loss of battery charger DC output
- ° Hi/Lo dc voltage (paralleled)

9.3.4 The transmission tone equipment used shall utilize a transmit and receive frequency in the ____ to ____ KHz band.

9.4 Master Requirements

The master station shall continuously interrogate in a sequential manner each of the remote stations, and report normal or off-normal conditions. The master station shall, as a minimum, include or display the following:

- ° Change of status
- ° Alarm status of each parameter interrogated
- ° Alarm disable to silence alarms from stations having intermittent alarms
- ° Indicate major or minor alarm

9.4.1 The master alarm unit and associated equipment must be capable of continuous operation without corrective maintenance under the following conditions:

- ° Operating Temperature Range ____°C to ____°C
- ° Ambient Humidity ____% to ____% non-condensing
- ° Power ____VDC to ____ VDC with ____MV p-p ripple

9.4.2 Transmit and receive terminals must have at least ___dB isolation. Spurious tones and harmonics that may be generated by either the transmit or receive equipment must be less than____dBmO outside of the operating bandwidth.

9.4.3 The master alarm unit shall operate from a ____ VDC power source.

The alarm equipment will be connected to power line carrier terminal and operate in the ____ to ____ KHz frequency band. The transmit and receive levels and the impedances shall be compatible with the equipment proposed.

9.4.4 The master station, as installed, shall:

- Be capable of indicating the site from which the alarm is being sent, as well as the specific alarm nature, without the necessity for the operator to depress any decode or select button
- Have both visual and audible alarms
- Display the identity of any site which has transmitted a change of status signal since the last system check
- Display the identity of stations which are in failure due to tone transmitter failure or no modulation of the tone transmitter
- When manually selected, display the status of each of the alarm points at each remote site
- Provide a visual indication of code check confirmation from the selected station
- Provide an audible alarm indication that may be silenced or acknowledged from a location other than the master station cabinet
- Provide a method to allow audible alarms to be selectively silenced on one or more faults without affecting any other alarm(s) that may occur before a particular alarm is corrected

9.5 Alarm Security

Alarm tones shall be coded to prevent false reporting. The coding security scheme shall be explained in detail by the Offeror.

9.6 Indicators

A means shall be provided for checking visual alarms without removing indicators from the master or remote units.

9.7 Master Station Printer

A master station printer shall be furnished and installed to provide a hard copy record of all changes of alarm status occurring in the system. Printer shall have ASCII output ports.

10.0 STATION BATTERY SYSTEM

10.1 General

The dc power shall be furnished and installed as indicated in this specification.

All electronic equipment shall operate directly from a dc power supply consisting of a float-charged battery and battery charger operated from the station's power source.

10.2 Battery

_____ storage batteries shall be provided, designed for communications use.

10.2.1 Ampere-Hour Capacity: The ampere-hour capacity of the battery at each station shall be sufficient to carry the load of that station, as determined on "Battery and Charger Calculation Work Sheets" to be furnished by the Offeror. The battery shall be capable of supplying the station load continuously for a period of ___ hours with electrolyte temperature of ____°C.

10.2.2 Number of Cells: Twelve cells for 24 volt and twenty four cells for 48 volt operation of the proposed equipment.

10.2.3 Grids: Offeror shall specify the percentage of calcium content.

10.2.4 Specific Gravity: The specific gravity of each cell shall be 1.210 ± 1.115 at ___°C after full charge. The cell voltage shall be between 2.20 and 2.30 volts when battery is floated at 2.25 volt per cell average.

10.2.5 Operation: All batteries furnished will be operating at a float voltage 2.25 volt per cell. No periodic equalization shall be required. The charger shall regulate the voltage to the battery terminals within ± 0.5 percent. The Offeror shall state the recommended maintenance for the batteries proposed.

10.3 Battery Rack

Battery racks shall be of the two-tier type. Frames, rails, and braces shall be made of steel. The final finish shall be an acid-resistant enamel.

10.4 Battery Records

The Offeror shall record the initial readings for the bus and each cell in accordance with the battery manufacturer's recommended procedures. The readings shall be witnessed by the duly authorized Purchaser's representative.

10.5 Cell Numerals

Plastic cell numerals shall be fixed to each cell starting with the numeral "1" at the positive terminal. The succeeding numbers shall then follow the electric circuit, ending with the numeral "12" or "24" on the cell at the negative terminal. The size of the plastic numeral shall be at least_____cm and no greater than _____cm. Each battery shall be assigned a serial number, which shall be fixed to each cell along with cell number at the factory.

10.6 Float Voltage

Batteries shall be suitable for float charge at 2.25 volt per cell.

10.7 Battery Connections

Electrical connections to the cell terminals shall use lead-plated copper lugs or straps to eliminate corrosion.

Intercell cell connectors and cables connecting the battery to the battery charger and the battery to the dc distribution cabinet shall be sized to coordinate with the battery charger dc output fuse.

10.8 Battery Accessories

Each site battery system shall be equipped with the following accessories:

- Hydrometer with markings every 10 points
- Thermometer, Battery
- Connector bolt wrench
- One acid-resistant container for storing the hydrometer
- Lifting sling and spreader block
- OSHA approved emergency eyewash kit

10.9 Discharge Curves

The Offeror shall provide copies of the battery manufacturer's discharge curves for each type of cell proposed. These curves shall be included in the Offeror's technical proposal, with calculations used to determine the capacity of the proposed batteries.

10.10 Battery Chargers

The battery chargers supplied under this specification shall provide full-wave rectification by means of silicon controlled rectifiers. These chargers will be used for float charging lead-calcium storage batteries. They shall operate from a 240 volt, single phase, 60 Hz source.

10.11 Standards

The following standards and specifications form a part of these specifications and, unless otherwise specified, all chargers shall be manufactured and tested in accordance with the applicable requirements of the following standards:

- National Electrical Manufacturer's Association (NEMA), Standard for Semiconductor Rectifiers Safety Code, Publication No. MR 1-1958
- EIA Standard No RS-262, Semiconductor Rectifiers Diodes, Class of Service Environmental and Test Requirements (NEMA Publication No. UD-49-1962)

10.12 Temperature Rise

Under continuous conditions and at maximum rated output with an ambient temperature of 40°C, the temperature rise of any charger component, shall not exceed the maximum continuous operating thermal limit specified in the individual standards of IEEE, NEMA and the National Electrical Code.

10.13 Operation

Chargers shall be supplied with control equipment to make them completely automatic as to output current and self-regulating as to output voltage. The output voltage shall be continuously adjustable over the range of 23 to 28 volts for the 24 volt batteries and 46 to 58 volts for the 48 volt battery. Controls that have erratic response will not be acceptable.

10.14 Regulation

The output voltage shall be constant $\pm$ one-half percent under the following conditions:

- Load: For any load from no-load to full-load
- AC Input Voltage: The ac input voltage variation of $\pm$ 10 percent
- Frequency: A frequency variation of $\pm$ ____ percent
- Completely independent of the battery

10.15 Current Limiting

The Chargers shall be self-limiting as to load current. The charger circuitry shall be such that the charger does not rely on the blowing of fuses or breakers to limit the current except under the short-circuit conditions. Limiting shall occur at 115 percent of maximum rated output.

10.16 Protection

The Chargers shall be equipped with fuses or protective devices to protect the charger components during fault conditions on the dc side of the charger, as well as during internal faults. Such protective devices shall provide fault protection on both the ac input and the dc output of the charger. The ac protection shall be properly coordinated with the dc protection for faults on the dc bus.

10.17 High Voltage

A high voltage sensing circuit shall be provided which will deenergize the charger output whenever the output voltage exceeds a preset voltage. This voltage shall be adjustable over the range of at least 26 to 29 volts for 24 volt batteries and 52 to 58 volts for a 48 volt battery in increments of 0.2 volt or less.

10.18 Discharge

Battery chargers shall be so constructed that the battery will not be discharged through the charger components during an ac supply outage. The current through the voltmeter or pilot light will not be considered as being sufficient to discharge the battery.

10.19 Capacity

Each battery charger shall have sufficient capacity to carry the full station load plus additional capacity sufficient to recharge a fully discharged battery within 24 hours after restoration of commercial power. The Offeror shall demonstrate the ability to meet this requirement by means of voltage and current measurement tests to the Purchaser's duly authorized representative at the time of acceptance. The full load capacity of the charger shall be specified by the Offeror in his proposal.

10.20 Control

The following control and instruments shall be provided on each battery charger panel:

- AC supply ON-OFF switch or circuit breaker
- Output voltage selector switches, adjustable knobs, for the adjustment of float charge voltage

10.21 Instruments

A dc voltmeter with a scale length of not less than _____ cm, with an accuracy of 2 percent, shall be provided on each charger.

A dc moving coil ammeter with an accuracy to within 2 percent of full scale shall be provided on each charger.

10.22 Alarms

The following alarms shall be provided with each battery charger:

- DC High Voltage alarm, adjustable from 26 to 29 volts for 24 volt chargers and 52 to 58 volts for 48 volt chargers
- DC Low Voltage alarm, adjustable from 21 to 26 volts for 24 volt chargers and 42 to 52 volts for 48 volt chargers
- Charge failure alarm relay

10.23 Enclosure

The Chargers shall be housed in metal enclosures designed to allow ready access for maintenance. The enclosures shall have sufficient louvers for adequate ventilation. Knockouts shall be provided convenient for the supply and load circuits. Terminals shall not be exposed when all covers are in place.

10.24 Terminals

All terminal blocks shall have their terminals marked to facilitate the identification of the particular terminal on the wiring or schematic diagram.

10.25 Filter

The output ripple voltage of the charger connected to the battery only, shall not exceed 30 MV rms.

10.26 Transformer

The battery charger shall have an isolating transformer with a dual primary winding.

10.27 Efficiency

The efficiency of the battery charger, at its rated full load with the nominal input voltage, shall be ___ percent, or greater.

10.28 Automatic Load Disconnect

The charger system shall be equipped with a load disconnect that automatically disconnects the load when the battery voltage goes below 21 volts on the 24 volt systems and 42 volts on the 48 volt systems.

10.29 Equalizing

The charger system shall be equipped with a timer assembly to permit equalizing of the battery bank. Equalizing system shall be defined.

10.30 Mounting

The charger system shall be of the rack mounting type for a standard EIA, 19 inch rack. This rack shall be floor mounted with the top of the charger at least ___ meters above the floor.

10.31 DC Power Boards

The dc power panel shall be provided for the distribution of dc power. The panel shall be equipped with indicator type fuses, as required by the station load. Redundant or standby equipment, if any, shall be powered from separate fuses. The panel shall be rack-mounted.

10.32 Ground Bus

The power board shall be equipped with a ground bus. The bus shall be drilled and tapped to accept solderless connectors. The ground bus shall also be rack-mounted and grounded to the relay rack.

10.33 Battery and Charger Servicing

Facilities shall be provided to enable the batteries and chargers to be maintained without interruption of service.

One set of Operation and Maintenance manuals shall be provided for each site, with two sets provided for office files.

11.0 INSTALLATION

11.1 General

All PLC equipment, and other materials shall be installed by the Contractor in a neat and professional manner, employing the highest standard of workmanship and in compliance with the National Electrical Code, Electronic Industry Association (EIA) standards, local building codes, applicable FCC of FAA standards and procedures, and standard construction procedures.

11.2 Specific

The Offeror shall furnish all equipment, materials, and services as required to provide a complete and functional system as described by these plans and specifications. Work at each site shall include, but not be limited to the following. All work shall be in compliance with the applicable drawings and/or specification requirements. In accomplishing installation, the Contractor shall:

- Extend temporary electrical service from fusible disconnect
- Install station signal grounding system
- Furnish and install line coupling, transmission, tuning, and channelization equipment
- Install lightning protection equipment
- Install communication equipment and all power and signal cables
- Install batteries, charger, and DC distribution panel. Panel to be furnished as part of communication equipment
- Install all interconnects between alarm contacts for communication equipment to alarm status panel
- Install ground bonds between communication equipment and station signal ground
- Install and connect the protective grounding system wire
- Install all inter-rack and communication equipment wiring
- Install such other facilities as required by these specifications

During the entire installation phases, it shall be the responsibility of the Contractor to coordinate all construction and installation activities with the Engineer to assure rapid and effective realization of the system to be furnished under these specifications.

12.0 TESTING

12.1 General

Communication equipment and other equipment and materials included in these specifications will be inspected and tested as appropriate by the Purchaser and the Engineer. The inspections and testing as specified herein will be conducted during the delivery and installation phases of the project, with final acceptance testing to be conducted at such time as the Contractor states that the system installation is complete, and ready for test.

The tests will be conducted to verify that all equipment called for by these specifications has been engineered, furnished and installed as specified, is functioning as called for, and that all work specified has been completed in accordance with the Purchaser's requirements.

12.2 Test Schedule

The Contractor shall provide the Purchaser with advance notification of tests to be conducted as follows:

- Factory Testing - ___ weeks
- Field Tests - ___ weeks

Field tests shall be conducted on subsystems by the Contractor on a basis to be specified by the Purchaser subsequent to contract award.

12.3 Test Procedures

Prior to initiating any tests, the Contractor shall develop a system test procedure and format for test documentation. It shall be the intent to allow the Contractor maximum flexibility in establishing test procedures in order to use procedures and practices familiar to the Contractor. If these procedures and practices are not acceptable to the Engineer, the procedures and practices established by the Engineer shall be used.

Prior to witnessing of field acceptance test by the Engineer, the Contractor shall conduct tests and record data for review and evaluation by the Engineer. The Contractor shall verify in writing that the system is ready for acceptance testing and that all facilities and systems are in compliance with the plans and specifications.

12.4 Retest Requirements

In the event that any facility is found to be deficient, or any communication test does not meet or satisfy the requirements of the specification for the test, action, as directed by the Purchaser's Engineer, shall be taken by the Contractor to correct the deficiencies noted, prior to additional system testing. Tests shall be conducted, as required, until the deficiencies are corrected, and the system is operationally acceptable.

12.5 Test Equipment

It shall be the responsibility of the Contractor to furnish all equipment required to conduct system tests. All equipment shall be calibrated and calibration data made available to the Engineer upon request.

Prior to initiation of acceptance tests, the Contractor shall submit a list of test equipment (by types) to be used. Equipment shall be as referenced in the Test Procedures.

Types, model numbers and serial numbers of specific equipment used for system testing shall be included with each station test report.

12.6 Factory Testing

Factory tests shall be conducted by the Contractor and witnessed by the Engineer. It is desirable to conduct all tests consecutively for the entire system; however, subsystem tests will be acceptable if required to expedite completion of the project. Tests shall include all items as noted herein.

Factory tests shall be conducted with levels and adjustments set for nominal conditions expected in the field.

Factory test data on the channelization equipment, shall be submitted to the Engineer for review and record purposes. If requested, sample tests shall be witnessed by the Engineer at no additional cost to the Purchaser.

12.6.1 The carrier transmission equipment shall be assembled at the Contractor's factory, where tests shall be performed both on an individual equipment basis, and on a segment basis to prove compliance with the performance objectives.

12.6.2 Contractor shall notify Purchaser at least _____ days prior to final factory testing and shipment to allow engineer and/or his representative to witness final testing of the equipment to be supplied.

12.6.3 Data recorded during factory testing will be compared with data obtained during field testing.

Offerors are to describe, in detail, their standard factory testing procedures and practices for each type of electronic equipment offered.

12.6.4 Contractor shall submit the factory test plan within ____ days after contract award for review and approval.

12.7 Field Tests

During the checkout and field testing, the Purchaser shall assign personnel to participate with the Contractor in the checkout of the system. A notification of _____ working days shall be given to engineer to allow for possible assignment of Purchaser's personnel. Offerors are to explain, in detail, their standard field testing practices and procedures for all equipment offered. The Contractor shall submit within 60 days of contract award a field test plan for review and approval.

12.7.1 Documentation

Data obtained during the field testing shall be fully documented, with the original copies of the documentation furnished to the Purchaser. The documentation shall include as a minimum, the following information:

- Site Name
- Test equipment utilized
- Signal-to-noise ratio on a segment basis
- Noise level on a segment basis
- Proper equipment levels in accordance with Contractor supplied block and level diagrams
- Proper and effective operation of all channelization equipment
- Proper and effective operation of all live coupling and tuning equipment

Data recorded during these tests shall be checked against that obtained during factory tests.

12.7.2 If guaranteed performance is not substantiated by the tests, necessary corrections will be made, and, upon completion thereof, demonstate to engineer that corrections have improved operation to the point that performance guarantees are obtainable.

12.8 Acceptance Tests

12.8.1 DC System Tests

The chargers and dc power boards shall be tested and adjusted to verify the following:

- Float voltage
- Charger operation
- Current limiting
- Meter accuracy
- Output ripple
- High-voltage trip and alarm
- Low-voltage switch operation
- Manual disconnect switch operation

The batteries shall be tested to verify the following:

- Cell voltage
- Cell specific gravity
- Battery bank voltage

The chargers shall be disabled for one hour and the above tests shall be performed again to check for defective cells in the battery bank.

12.8.2 Fault Alarms

12.8.2.1 The fault alarm system shall be tested at both the remote sites and master station. Alarms will be simulated by jumpering of the contacts or other similar method.

12.8.2.2 Carrier transmitters shall be tested for proper transmit levels, with each fault point tested by simulating a fault. A check shall be made to verify that the proper alarm indicator on the transmitter is activated and that the fault is reported properly at the master station.

12.8.2.3 The audible and visual alarms at the master receiver station shall be tested.

12.8.3 Channelization

12.8.3.1 The channelization equipment shall be fully tested, with the tests performed in accordance with accepted procedures, and all data taken shall be recorded. The following tests shall be performed:

- Channel frequency response
- Channel crosstalk
- Harmonic distortion
- Intermodulation products
- Signaling speed and sensitivity
- Channel level stability
- Power supply voltage and ripple
- Proper operation of all alarms
- Operation of control and indicators
- Delay distortion
- Idle channel noise
- Carrier leak

All measurements shall be made after all levels have been properly adjusted.

12.8.3.2 Channel frequency response tests shall be made from mod-in to far end demod-out.

12.8.3.3 Crosstalk measurements shall be made on an individual channel basis for both near-end and far-end crosstalk.

12.8.3.4 The crosstalk performance shall be measured using a Western Electric 3A or equivalent.

12.8.3.5 Harmonic distortion tests shall be made using a 1 KHz test tone at 0 test tone level as a reference signal. A harmonic wave analyzer shall be used at the equipment receiving terminal to measure the level of the fundamental and harmonics of the applied signal.

12.8.3.6 The idle channel noise of each carrier drop, shall be measured using a Western Electric 3A or equivalent.

12.8.3.7 Carrier leak shall be tested and shall not exceed the Manufacturer's specifications.

12.8.4 Sensing and Alarm Circuits

12.8.4.1 All sensing circuits shall be tested for proper operation. Range of all variable devices shall be tested to assure that reserve adjustment is available, if required. Equipment failure and fuse alarms shall be tested and checked to verify that the proper point on the fault alarm is activated and the required visual and/or audible alarms occur.

12.8.4.2 All meter indications shall be tested to assure proper function. Range of adjustments for meter indication shall be tested.

12.8.5 Segment

12.8.5.1 Each power line carrier segment to verify compliance with the plans and specifications. Tests shall include, but not be limited to the following:

- Transmitter frequency
- Transmitter power
- Nominal receive level
- Noise measurements
- Coupling loss
- Insertion loss
- Bandwidth
- Attenuation versus frequency
- Channelization tests

12.8.5.2 Where applicable, results of tests shall equal or exceed specified, and Contractor supplied performance data. Link tests shall be witnessed by the Engineer.

12.9 System Acceptance

12.9.1 General

Acceptance of the Communications System shall be on a system basis. _____ days prior to completion of the system, the Contractor shall notify the Purchaser. This will allow a coordinated inspection, testing and acceptance schedule to be organized by the Contractor and the Purchaser.

12.9.2 Acceptance Criteria

Communication equipment will be accepted if the physical equipment is furnished and installed in accordance with the specifications and the communication or electrical performance characteristics of these specifications are satisfied.

Upon compliance with plans and specifications, the entire system or subsystems will be accepted as complete as determined by the Purchaser and the Engineer.

12.9.3 Station and System Acceptance

Owner reserves the right to perform or have performed by the Contractor any testing to verify system specifications. Acceptance of part of any system will not obligate Purchaser to accept remaining parts of the system. Warranties shall not commence until final system acceptance.

The Purchaser will not make final payment to Contractor until the Purchaser's Engineer has certified that the communications system furnished and tested by the Contractor is operating in conformance with specifications and guarantees.

13.0 DOCUMENTATION

13.1 Within ____ days subsequent to date of contract award, the contractor shall furnish for Purchaser approval, a minimum of ____ sets of preliminary systems drawings and documentation consisting as a minimum of the following:

13.1.1 A key or index sheets listing in a numerical sequence all drawings and descriptive literature.

13.1.2 Rack elevations showing rack dimensions on all equipment units and their location on the racks.

13.1.3 _____ operational instruction books, including schematic diagrams for each different type of unit furnished shall be sent with the preliminary drawings to facilitate interpretation and approval of the drawings.

13.1.4 Operational block diagrams covering system function, alarm system and signal flow.

13.1.5 Manufacturer's assembly and installation drawings for antennas.

13.1.6 Communication equipment building physical layouts and dimensions. Included shall be drawings and descriptive data on all equipment included as part of the equipment building.

13.1.7 Drawings showing physical mounting details of all equipment and hardware furnished.

13.1.8 Details on station and equipment grounding.

13.1.9 Detailed building wiring drawings showing wire sizes and runs.

13.1.10 Wiring harness drawings and cable running lists for all racks, to include wiring of all plug-in shelf assemblies, showing wiring connections between units on a shelf and inter-rack wiring. Where vendor standard wiring assemblies are used, they shall be marked or otherwise cross-referenced to indicate applicable options and strappings. Units wired but not equipped shall be so indicated. External connections to all racks. All external connections, such as for power, alarm, audio, etc., shall be cross-referenced on the key or indexed sheets.

13.2 The Contractor shall furnish for approval, within ____ days after the contract award, his proposed system test procedures.

13.3 The Purchaser will, within ____ days after receipt of prints of drawings and design analysis for approval, forward one copy of each to the Contractor marked with one of the following:

13.3.1 Approved: Prints so marked will authorize the Contractor to proceed with the fabrication of the equipment.

13.3.2 Approved With Corrections: Prints so marked will authorize the Contractor to proceed with the fabrication of the equipment in accordance with indicated corrections. The Contractor shall make the necessary drawing revisions.

13.3.3 Returned for Correction: The Contractor shall make the necessary corrections and revisions on the drawings as indicated and shall resubmit prints for approval. Time required for such revision of drawings and resubmission of prints will not entitle the Contractor to any extension of time.

13.3.4 Work accomplished, or materials ordered, by the Contractor, prior to receipt of prints marked Approved or Approved With Corrections As Noted, shall be at the Contractor's risk. Approval by the Purchaser shall not relieve the Contractor of the responsibility for the correctness of the drawings furnished by the Contractor nor for their compliance with the specifications.

13.4 The contractor shall furnish, within ____ days after system cutover the following documentation and manuals:

13.4.1 ____ sets of Instruction Manuals, covering the communications equipment, incorporating, as a minimum the following information:

13.4.1.1 Complete system installation, operating, and line-up instructions.

13.4.1.2 Instructions for each different equipment unit furnished, including operating and maintenance instructions, parts lists, and schematic diagrams.

13.4.1.3 For units not manufactured by the power line carrier equipment supplier, the manufacturer's name and his identifying part number shall also be furnished.

13.4.1.4 Operational block diagrams covering all system functions.

13.5 The Contractor shall supply for each site, _____ copies of a certified factory test report. This test report shall contain data and meter readings taken during final factory alignment of equipment. No equipment will be acceptable which has a reading or readings not within the stipulated and agreeded upon tolerances listed in the instruction book. The test report shall contain overall system performance data to indicate compliance with all system tests. Three copies of system test reports containing the overall system performance data of the system field tests shall be furnished within _____ days after completion of tests.

13.6 The Contractor shall prepare a set of "as-built" drawings and submit these to the Purchaser's Engineer for final approval.

13.7 The successful Contractor shall be responsible for placing the Purchaser's name and address on the mailing lists of the manufacturers of all items furnished under these specifications, so that the Purchaser may receive all literature and data associated with any design modifications or alterations made by the manufacturers subsequent to the acceptance of the system by the Purchaser, and for period of _____ years.

14.0 SPARE PARTS AND TEST EQUIPMENT

14.1 General

This section describes the requirements for spare parts and test equipment for the operation and maintenance of the system to be furnished. Parts, modules and test equipment to be recommended by the Offeror, but not manufactured by him, shall be indicated as such, and the manufacturer of the item stipulated. Common parts such as transistors, diodes, etc., that are available from more than one source shall be shown as such and the manufacturer's name will not be required.

The unit price of each item of Offeror manufactured test equipment shall be shown, indicating any discount advantage obtained by purchasing the test equipment from the Offeror at the time the system is ordered.

14.2 Spare Parts and Modules

A recommended spare parts list for the first year of operation on the system shall be provided. The spare parts list shall include prices of the individual modules, sub-assemblies, or spare parts as itemized and the total spare parts cost shall be given as required in this specification.

Spares for the equipment shall be recommended at the module level of repair and maintenance. This shall include sub-assemblies, modules and plug-in units.

Facilities available for return of units, subsystem, sub-assemblies and modules to the manufacturer for repair shall be described by the Offeror. The turn around time, for shipping the unit in for repair, and return, shall be stated by the Contractor.

Spare parts and modules shall be available for _____ years after acceptance of the system by the Purchaser.

14.3 Test Equipment

A list of test equipment required for maintenance of the proposed system shall be provided. It shall indicate the suggested minimum amounts and types of equipment required for proper maintenance. In addition, test equipment should be recommended to perform complete equipment alignment, testing and repair. If test equipment is of other manufacture than by the contractor, it shall be so indicated.

15.0 TRAINING

15.1 General

The Offeror shall conduct a complete maintenance and operation training program for up to _____ persons. This program shall consist of at least ____ hours of instruction, including the general theory of operation. Test procedures to be followed in keeping the equipment in operating condition, emergency procedures, and routine maintenance acts shall include actual adjusting and testing of equipment furnished to the Purchaser on other equipment of the same type.

The Offeror shall submit costs for training to be conducted at the factory or at the Purchaser's location.

Training and instruction for the equipment shall be provided for the Purchaser's maintenance personnel to enable them to become familiar with the equipment supplied by the Contractor. In addition, the Contractor shall furnish educational material for dissemination to customers, covering the function and operation of equipment located on the customer premises. There shall be a maximum of _____ training sessions of _____ days each.

15.2 Classroom Training

The Offeror shall state in his proposal if factory training is available to Purchaser's personnel, and shall provide the curriculum cost of such training with his proposal.

15.3 On-the-Job Training

The successful Contractor shall provide on-the-job training (on an informal basis) for Purchaser's operating and service personnel in equipment operation and maintenance of the actual equipment installed. This on-the-job training shall be done concurrently with the installation and initial field testing of the communications system.

As part of his response, the Offeror shall state the number of personnel, and their qualifications as instructors that he will use to train, _____ technicians in the testing and maintenance of the equipment.

This on-the-job training shall include all of the communications equipment supplied under this specification.

16.0 MAINTENANCE AND MAINTENANCE RECORDS

The Contractor shall maintain the installed equipment from the time of equipment installation to the time of system acceptance. Maintenance shall be such as to maintain equipment to the performance levels as specified within.

If the Purchaser so elects, a maintenance contract shall be developed to extend maintenance for a period of one year from the date of system acceptance. During this period, the system shall be maintained at level of performance as specified herein. At the termination of the first years contract, the Contractor shall conduct tests, set levels, and correct deficiencies as required to establish performance level of the system to the specifications contained herein. Test procedures as developed for the initial system tests shall be used and results documented.

Maintenance by the Contractor will be in accordance with these requirements:

- Replacement parts shall be at least of equal quality and ratings as the original parts
- Any water, oil, dust, or other foreign substance will be removed from the equipment, its parts and attachments
- Performance of the equipment will be kept at the level stated in the Purchaser's performance specifications
- Routine maintenance procedures prescribed or recommended by the Contractor for his equipment shall be followed
- The Contractor shall provide only factory trained and authorized maintenance personnel
- The Contractor shall supply comprehensive installation and maintenance manuals as part of this equipment purchase
- Service shall be provided on a 24-hour emergency call basis with on-site response within four hours after call

If there is any discrepancy between the maintenance obligations of the Contractor as represented by the standards of maintenance set out herein, the Contractor's Maintenance Agreement, the bid documents, or the proposal, the maintenance

obligations and standards most favorable to the Purchaser shall apply. The Contractor shall keep accurate records of all maintenance performed on each piece of equipment identified by serial number, including routine or preventive maintenance and emergency repairs, and shall make all records available for inspection by the Purchaser or his designee at any time upon reasonable request.

APPENDIX A

Equipment Design Data

1. Environmental Criteria

a.	Temperature Range	_____ to _____ C
b.	Humidity	Up to _____% at_____ C
c.	Altitude	Up to _____ meters
d.	Transient Withstand Capability	_____V, _____ MHz per IEEE 472 - 1974 (ANSI C37.90 - 1974)

2. Carrier Equipment

a.	Bandwidth per channel	_____ KHz
b.	Frequency Range	_____ to _____ KHz
c.	Frequency Stability	± _____ Hz at _____ KHz
d.	Sensitivity	_____ dBm
e.	AGC Regulation	± _____ dB
f.	Selectivity	
	(1) Overall	More than _____ dB down
	(2) Channel	_____ dB down
g.	Minimum Channel Spacing (Adjacent)	_____ KHz
h.	Image Rejection	_____ dB down
i.	Spurious Output	_____ dB down
j.	RF Impedance	_____ Ohms
k.	Pilot Level	_____ dBmO

3. Channel Equipment

a.	Voice Frequency Response	_____ to _____
b.	Bandwidth	
	(1) Nominal	_____ Hz
	(2) _____	_____ Hz

c. Voice Level with 100% Modulation

	2 wire Termination	4 wire Termination
(1) Input Range	_____ to _____ dBm	_____ to _____ dBm
(2) Output Range	_____ to _____ dBm	_____ to _____ dBm

d. Tone and Data Levels with 100% Modulation

	4 wire Termination
(1) Input Range	_____ to _____ dBm
(2) Output Range	_____ to _____ dBm

e. Envelope Delay

Frequency Range	Max Envelope Delay
_____ to _____ Hz	_____ microseconds
_____ to _____ Hz	_____ microseconds
_____ to _____ Hz	_____ microseconds
_____ to _____ Hz	_____ microseconds

f. Input and Output Impedance

_____

g. Level Stability

(1) With Compandor ± _____ dB

(2) Without Compandor ± _____ dB

h. Signaling

(1) Frequency _____ Hz

(2) Level Stability _____ dB

(3) Frequency Stability _____ Hz

(4) Minimum S/N _____ dB

(5) Dialing Speed _____ pulses per second

(6) Dialing Make-Break Ratio _____ % ± _____ %

(7) Maximum Loop Resistance _____ Ohms

4. Compandor

a. Supply Voltage _____ V

b. Transmit Level _____ dBm

c. Receive Level _____ dBm

d. Impedance _____ Ohms

e. SNR - In _____ dB

f. SNR - Out _____ dB

g. Threshold Level _____ dBm

5. Audio Bridge

   a. Audio Bandwidth _____ to _____ Hz

   b. Impedance _____ Ohms

   c. Input Power Requires

      (1) _____ VDC

      (2) _____ MA

   d. Common Battery Requirements

      (1) _____ V

      (2) _____ Hz

      (3) _____ Watts

   e. Local Battery Requirements

      (1) _____ V

      (2) _____ Hz

      (3) _____ Watts

6. Line Tuner

   Characteristics are to be provided by supplier in accordance with the specific requirements determine during the system design.

7. Line Traps

   Characteristics are to be provided by supplier in accordance with the specific requirements determine during the system design.

8. Coupling Capacitors

   Characteristics are to be provided by supplier in accordance with the specific requirements determine during the system design.

9. Coupling Capacitor Potential Devices

   Characteristics are to be provided by supplier in accordance with the specific requirements determine during the system design.

APPENDIX B

Link Data/Design Summary Worksheets

PLC SIGNAL-TO-NOISE CALCULATIONS

STATION NAMES	LINE SECTION	
Line Length, Miles/Line Voltage, kV		
Type of Coupling		
Type of PLC Equipment		
Transmit/Receive Frequencies, KHz		
Channel Loading - Voice		
- Tone		
- Signaling		
Effective Transmit Power (20W) dBm		
- Voice		
- Tone		
- Signaling		
Coupling & Shunt Loss, dB		
Net Transmit Power dBm		
- Voice		
- Tone		
- Signaling		
Miscellaneous Losses, dB		

Weater Conditions	Fair	Adverse	Fair	Adverse
Line Attenuation, dB				
Total Section Loss, dB				

Received Signal, dBm		
- Voice		
- Tone		
- Signaling		
Noise Level, dBm		
Signal-To-Noise Ratio, dB		
- Voice		
- Tone		
- Signaling		
Recommended Power, Watts		
Compandors Used (Yes/No)		
Revised SNR, dB - Voice		
- Tone		
- Signaling		

DESIGN PERFORMANCE PARAMETERS

Circuit _____ to Circuit _____
Ø _____ Ø _____

1. Surge Impedance _____
2. Line Noise (Random) _____
3. Corona Noise _____
4. Impulse Noise _____
5. Transposition Losses _____
6. Transmit Power Level _____
7. Frequency Stability _____
8. Receiver Bandwidth _____
9. Received Signal Level _____
10. Audio Output _____
11. Transmission Line Losses _____
12. Shunt Losses _____
13. Series Losses _____
14. By-pass Losses _____
15. Branch Circuit Losses _____
16. Reflection Losses _____
17. Noise Due to Distortion _____
18. Losses Due to Alternate Path at Substation _____
19. Fault Attenuation _____
20. Coupling Factor _____
21. Analog Signal Characteristics _____
22. Digital Signal Characteristics _____
23. Receiver Noise _____
24. Error Rate _____
25. Signal-to-Noise Ratio _____

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